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| **Section 1.3** | **Representing Earth’s Surface** |

**Key Concepts**

* [What lines on a globe are used to indicate location?](javascript:openCrossRef('../ch1/ch1_s3_1.html%23lnk11.4'))
* [What problems do mapmakers face when making maps?](javascript:openCrossRef('../ch1/ch1_s3_2.html%23lnk12.6'))
* [How do topographic maps differ from other maps?](javascript:openCrossRef('../ch1/ch1_s3_3.html%23lnk14.2'))

**Vocabulary**

* [latitude](javascript:openCrossRef('../ch1/ch1_s3_1.html%23lnk11.4'))
* [longitude](javascript:openCrossRef('../ch1/ch1_s3_1.html%23lnk11.4'))
* [topographic map](javascript:openCrossRef('../ch1/ch1_s3_3.html%23lnk14.2'))
* [contour line](javascript:openCrossRef('../ch1/ch1_s3_3.html%23lnk14.3'))
* [contour interval](javascript:openCrossRef('../ch1/ch1_s3_3.html%23lnk14.3'))

**Reading Strategy**

**Monitoring Your Understanding** Preview the Key Concepts, topic headings, vocabulary, and figures in this section. List two things you expect to learn. After reading, state what you learned about each item you listed.

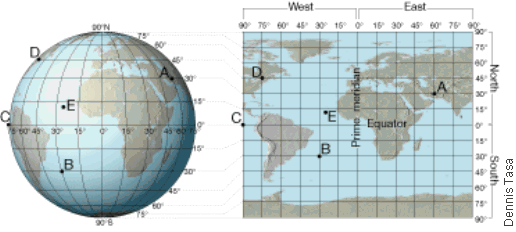
**Determining Location**

Today we use maps and computer programs to help us plan our routes. Long ago, people had to rely on maps that were made using data and information that were collected by travelers and explorers. Today computer technology is available to anyone who wants to use it. Mapmaking has changed a lot throughout recorded history.

After Christopher Columbus and others proved that Earth was not flat, mapmakers began to use a global grid to help determine location.

**Global Grid**

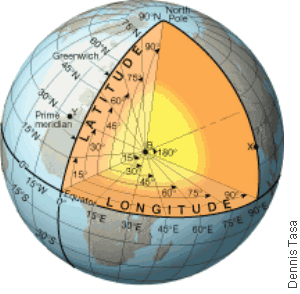
Scientists use two special Earth measurements to describe location. The distance around Earth is measured in degrees. [**Latitude**](javascript:openGlossaryWnd('e_ga_06_latitude'))**is the distance north or south of the equator, measured in degrees.** [**Longitude**](javascript:openGlossaryWnd('e_ga_06_longitude')) **is the distance east or west of the prime meridian, measured in degrees.** Earth is 360 degrees in circumference. Lines of latitude are east-west circles around the globe. All points on the circle have the same latitude. The line of latitude around the middle of the globe, at 0 degrees (°), is the equator. Lines of longitude run north and south. The prime meridian is the line of longitude that marks ° of longitude as shown in Figure 8.



**Figure 8 Global Grid**

Lines of latitude and longitude form a global grid. This grid allows you to state the absolute location of any place on Earth. For example, Savannah, Georgia, is located at 32° north latitude and 81° west longitude.

The equator divides Earth in two. Each half is called a hemisphere. The equator divides Earth into northern and southern hemispheres. The prime meridian and the 180° meridian divide Earth into eastern and western hemispheres.



**Figure 9 Measuring Latitude and Longitude**

**Reading Che**

(a)How does the global grid divide Earth?

**Globes**

As people explored Earth, they collected information about the shapes and sizes of islands, continents, and bodies of water. Mapmakers wanted to present this information accurately. The best way was to put the information on a model, or globe, with the same round shape as Earth itself. By using an accurate shape for Earth, mapmakers could show the continents and oceans of Earth much as they really are. The only difference would be the scale, or relative size.

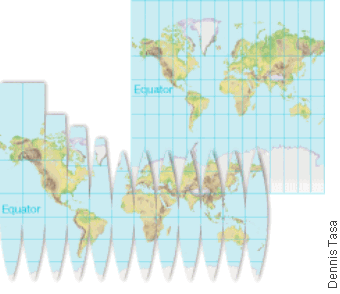
But there is a problem with globes. Try making a globe large enough to show the streets in your community. The globe might have to be larger than your school building! A globe can’t be complete enough to be useful for finding directions and at the same time small enough to be convenient for everyday use.

**Maps and Mapping**

A map is a flat representation of Earth’s surface. But Earth is round. Can all of Earth’s features be accurately represented on a flat surface without distorting them? The answer is no. **No matter what kind of map is made, some portion of the surface will always look either too small, too big, or out of place. Mapmakers have, however, found ways to limit the distortion of shape, size, distance, and direction.**

**The Mercator Projection**

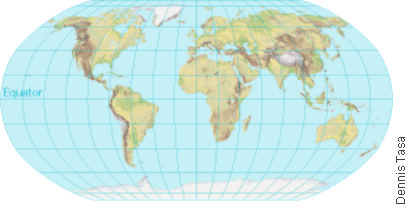
In 1569, a mapmaker named Gerardus Mercator created a map to help sailors navigate around Earth. On this map, the lines of longitude are parallel, making this grid rectangular, as shown on the map in Figure 10. The map was useful because, although the sizes and distances were distorted, it showed directions accurately. Today, more than 400 years later, many seagoing navigators still use the Mercator projection map.



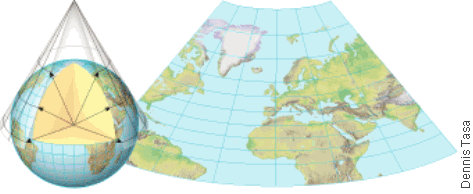
**Figure 10 Mercator Map** To make a Mercator map, mapmakers have to carve an image of Earth’s surface into slices and then stretch the slices into rectangles. Stretching the slices enlarges parts of the map. The enlargement becomes greater toward the north and south poles. **Observing** What areas on the map appear larger than they should?

**Different Projection Maps for Different Purposes**

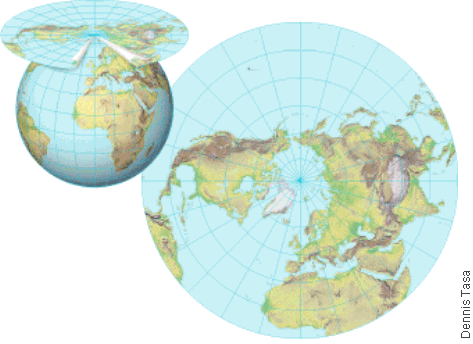
The best projection is always determined by its intended use. The Robinson projection map is one of the most widely used. Maps that use this projection show most distances, sizes, and shapes accurately. However, even a Robinson projection has distortions, especially in areas around the edges of the map. You can see this in Figure 11. Conic projection maps are made by wrapping a cone of paper around a globe at a particular line of latitude, as shown in Figure 13. Various points and lines are projected onto the paper. There is almost no distortion along the line of latitude that’s in contact with the cone, but there can be much distortion in areas away from this latitude. Because accuracy is great over a small area, these maps are used to make road maps and weather maps. Gnonomic projections, as shown in Figure 13, are made by placing a piece of paper on a globe so that it touches a single point on the globe’s surface. Various points and lines are then projected onto the paper. Although distances and directions are distorted on these maps, they are useful to sailors and navigators because they show with great accuracy the shortest distance between two points.



**Figure 11 Robinson Projection Map** Compare this map to the Mercator projection. **Comparing And Contrasting** How do the shapes in the continents differ between these maps? Are there any other differences?



**Figure 12 Conic Projection Map** Because there is little distortion over small areas, conic projections are used to make road maps and weather maps.



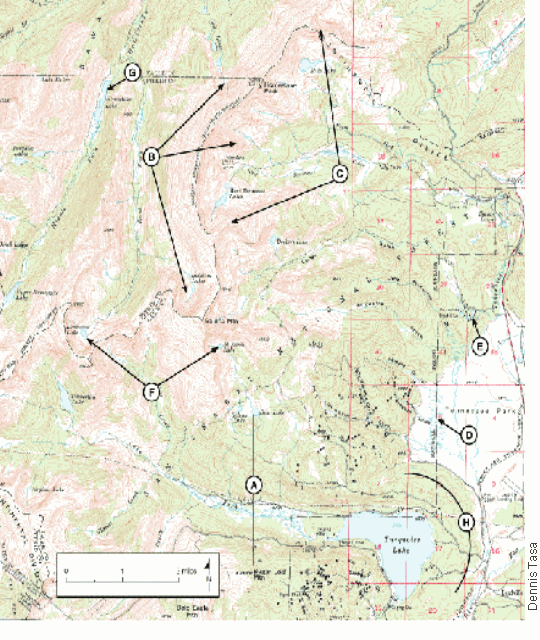
**Figure 13 Gnomonic Projection Map** Gnomonic projections allow sailors to accurately determine distance and direction across the oceans.

**Reading Checkpoin**

(a)What major problem must mapmakers overcome?

**Topographic Maps**

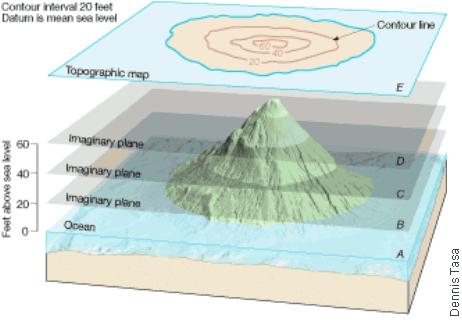
A [**topographic map**](javascript:openGlossaryWnd('e_ga_06_topographmap')), like the one shown in Figure 15, represents Earth’s three-dimensional surface in two dimensions. **Topographic maps differ from the other maps discussed so far because topographic maps show elevation. Topographical maps show elevation of Earth’s surface by means of contour lines.** Most also show the presence of bodies of water, roads, government and public buildings, political boundaries, and place names. These maps are important for geologists, hikers, campers and anyone else interested in the threedimensional lay of the land.



**Figure 15 Topographic Map** This is a portion of the Holy Cross, Colorado, topographic map. Contour lines are shown in brown.

**Contour Lines**

The elevation of the land is indicated by using [**contour lines**](javascript:openGlossaryWnd('e_ga_06_contourline')). Every position along a single contour line is the same elevation. Adjacent contour lines represent a change in elevation. Every fifth line is bold and labeled with the elevation. It is called an index contour. The [**contour interval**](javascript:openGlossaryWnd('e_ga_06_cntourinterv')) tells you the difference in elevation between adjacent lines. The steepness of an area can be determined by examining a map. Lines that are closer together indicate a steeper slope, while lines farther apart indicate a gentler slope. You can see this relationship on the illustration in Figure 14. Contour lines that form a circle represent a hill. A depression is represented by circular contours that have hachure marks, which are small lines on the circle that point to the center. Contour lines never touch or intersect.



**Figure 14** This illustration shows how contour lines are determined when topographic maps are constructed.

**Reaing Checkpoint**

(a)How do topographic maps indicate changes in elevation?

**Scale**

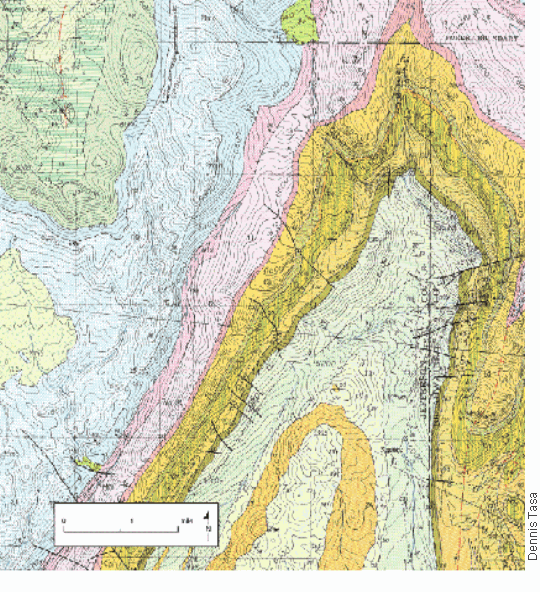
A map represents a certain amount of area on Earth’s surface. So it is necessary to be able to determine distances on the map and relate them to the real world. Suppose you want to build a scale model of a boat that is 20 feet long. If your model is a 1/5-scale model, then it is 4 feet long.

In a similar way, a map is drawn to scale where a certain distance on the map is equal to a certain distance at the surface. Because maps model Earth’s surface, the scale must be larger than that of the model boat. Look at the scale on the map in Figure 16. The ratio reads 1:24,000. This means that 1 unit on the map is equal to 24,000 units on the ground. Because the ratio has no units, it may stand for anything. We usually use inches or centimeters for our units. If the 1 stands for 1 centimeter on the map, how many kilometers does the 24,000 stand for on the ground?

Another scale provided on a map is a bar scale. See Figure 15. This allows you to use a ruler to measure the distance on the map and then line the ruler up to the bar to determine the distance represented.

**Geologic Maps**

It is often desirable to know the type and age of the rocks that are exposed, or crop out, at the surface. This kind of map is shown in Figure 16. **A map that shows this information is called a geologic map.** Once individual rock formations are identified, and mapped out, their distribution and extent are drawn onto the map. Each rock formation is assigned a color and sometimes a pattern. A key provides the information needed to learn what formations are present on the map. Contour lines are often included to provide a more detailed and useful map.



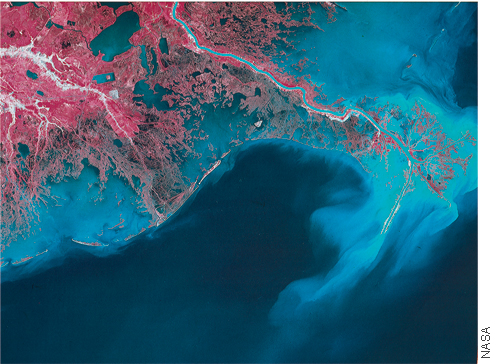
**Figure 16 Geologic Map** The color coding on the map represents some rock formations in Montana. Each color and pattern represents a different type of rock.

[ **For: Links on mapping** **Visit: www.SciLinks.org** **Web Code: cjn-1013**](http://www.phschool.com/webcodes10/index.cfm?fuseaction=home.gotoWebCode&wcprefix=cjn&wcsuffix=1013)

**Advanced Technology**

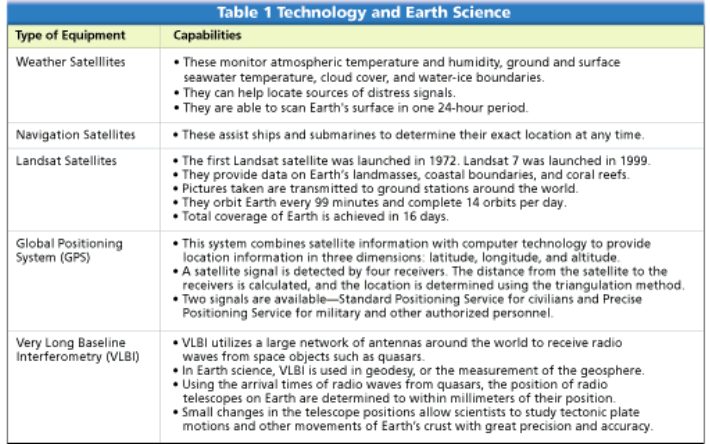
Advanced technology is used to make maps that are more accurate than ever before. **Today’s technology provides us with the ability to more precisely analyze Earth’s physical properties.** Scientists now use satellites and computers to send and receive data. These data are converted into usable forms such as pictures and numerical summaries.

The process of collecting data about Earth from a distance, such as from orbiting satellites, is called remote sensing. Satellites use remote sensing to produce views of Earth that scientists use to study rivers, oceans, fires, pollution, natural resources, and many other topics. How might a scientist use the image shown in Figure 17?



**Figure 17 Satellite Image of the Mississippi River Delta** Moving sediment (light blue) indicates current patterns. Red shows vegetation.

We can use this technology in our daily lives too. For example, Global Positioning Systems (GPS) can provide maps in our cars to help us reach our destinations. GPS consists of an instrument that receives signals to compute the user’s latitude and longitude as well as speed, direction, and elevation. GPS is an important tool for navigation by ships and airplanes. Scientists use GPS to track wildlife, study earthquakes, measure erosion, and many other purposes. Table 1 describes some of the technology that is particularly useful in the study of Earth science.



**SECTION 1.3 Assessment**

**Reviewing Concepts**

(1)Describe the two sets of lines that are used on globes and some maps. [](javascript:openCrossRef('../ch1/ch1_s3_1.html%23lnk11.4'))

(2)What happens to the images on the globe when they are transferred to a flat surface? [](javascript:openCrossRef('../ch1/ch1_s3_2.html%23lnk12.6'))

(3)What is the purpose of contour lines on topographic maps? [](javascript:openCrossRef('../ch1/ch1_s3_3.html%23lnk14.3'))

(4)What two lines mark zero degrees on the globe? In which directions do these lines run? [](javascript:openCrossRef('../ch1/ch1_s3_1.html%23lnk12.2'))

(5)Why is the Mercator projection map still in use today? [](javascript:openCrossRef('../ch1/ch1_s3_2.html%23lnk12.7'))

(6)What types of advanced technology are used in mapmaking today? [](javascript:openCrossRef('../ch1/ch1_s3_4.html%23lnk16.2'))

**Critical Thinking**

(7) **Applying Concepts** Why are there so many different types of maps? [](javascript:openCrossRef('../ch1/ch1_s3_2.html%23lnk12.6'))

(8) **Drawing Conclusions** How can data from VLBI be used in mapmaking today? [](javascript:openCrossRef('../ch1/ch1_s3_4.html%23lnk16.4'))

(9) **Conceptualizing** An area on a topographic map has the following contour line configuration: First, the lines are fairly widely spaced. Then they are closely spaced. Finally, they are circular. Describe the topography represented by these lines. [](javascript:openCrossRef('../ch1/ch1_s3_3.html%23lnk14.3'))

**Math Practice**

~~Use the bar scale on Figure 15 to answer the following question.~~

~~(10)Determine the distance along the shoreline of Turquoise Lake from the gaging station on the west shore to the gaging station on the south shore. Record your answer in kilometers. [](javascript:openCrossRef('../ch1/ch1_s3_3.html%23lnk14.2'))~~